Nova - A History – Written by Peter Rose, Founder

NOVA - A HISTORY

The Directors of SEN meet four times a year and in April the Board Meeting was held in the peace and beauty of Hakone as a little celebration of the fine performance of the company during the past year. We were not only able to enjoy our surroundings, but also could review our business and make plans for future exciting activities. During our meetings, your President Mr. Yamasaki asked me to write a short history of our company and I am pleased that he did because the story is quite interesting, but probably would never have been written without Mr. Yamasaki's suggestion. He tells me this article will appear in the SEN newspaper and I decided the story would be more interesting to you if I wrote it in a very personal way.

Late in 1977, I was still the President of Extrion and although business was good, and the company was growing, and we were investing not only in implanter developments but also in E-Beam Lithography. For various reasons my relationship with Varian's management was becoming difficult particularly because we were inadequately financed to successfully develop E-Beam Lithography and when I was replaced as President as a result of disagreements, I decided to leave.

When I left Extrion my close associates Andrew Wittkower, Geoffrey Ryding and George Swanson and many others requested me to start another company so they could join the new company, and we could work together again. A group of us had been working colleagues and close personal friends for more than 20 years and many of us did not like the Varian-style of management. Andrew Wittkower and I thought that possibly a new business could be built around metals implantation and in the first few weeks after leaving, I spent most of my time learning about metals application as well as trying to find some company or venture capitalists who would be willing to fund a metals implantation company.

In January of 1978 knowing that I had left Varian/ Extrion, I was contacted by Lou Steen of Kasper, a division of Cutler-Hammer before Cutler-Hammer was acquired by Eaton. He asked me if I would be interested in starting a company to build a high current ion implanter for the semiconductor industry. If I was willing to do this, then he thought that Cutler-Hammer might be persuaded to fund me. Cutler-Hammer had already acquired a medium current implanter company originally called Eltek whose president was the same, Al Noonan, who still is actively with us today. Naturally, Andrew, Geoff, George and I were very puzzled that Cutler-Hammer wished to start another implanter company. It was explained to us that Eltek was not doing well, something which of course we knew and we realised a high current implanter product would give Cutler-Hammer an advantage over Varian/Extrion especially if we would do it. Funding for a metals implantation business was not materializing and we had decided even before Lou Steen contacted me that a high current machine capable of 10mA of beam, something Varian/Extrion was not doing, would be a good idea. We decided to give up the idea of metals implantation and wrote a plan to develop a high current implanter for the semiconductor market.

Nova Associates was incorporated in March 1978 and George Swanson joined me at that time. Cutler-Hammer decided to fund us by May of that year and money became available to start operation of the company in August. At that time Andrew Wittkower and a little later Geoff Ryding joined George and myself and we were ready to go to work.

Just at the time we were funded, Cutler-Hammer was acquired by Eaton and you can imagine for a while we were quite frightened that our new venture would be stopped before it was truly started. Luckily, we continued to be supported strongly by the senior people of what had been Cutler-Hammer and fortunately before Eaton really paid any attention to us the development of our first machine was well along and pretty much on plan so we were warmly welcomed into the Eaton family.

The four of us that founded Nova took very similar roles to those we held at Extrion. I was President, Andrew Wittkower, Executive Vice President, Geoff Ryding, Vice President and Director of Engineering, and George Swanson, Vice President and Director of Marketing. As I have told you, we had worked together for many years before we started Extrion. (We had worked together at High Voltage Engineering.) This made for a situation of complete trust. We were adjusted to our strengths and many weaknesses and had only one objective which was to develop the best high current implanter we could and to do this as quickly as possible. Incidentally, some of us developed the High Voltage Engineering implanter that, I believe, was eventually licensed by Nissin in the very early 1970's.

For the first few months the company operated out of a few offices loaned to us by a business colleague. The offices were in a building that had been a chicken hatchery. Our surroundings were very modest and when it rained, mud from the dirt road outside was carried in by our feet all over the office. It was not long (October) before we found better premises in Beverly near our present Eaton/Nova building and it was there we started to hire people and get down to business. We had decided not to employ people from our old company Extrion. We stuck to our principles for a while, but it was not long before some wonderful people like Marvin Farley, and some others joined us. I am very glad that they did even though it annoyed Varian very much.

We decided just as we had when we started Extrion that the first and most important decision we need to make was to decide on the type of target chamber we would use. We quickly and unanimously decided that we would use a spinning disk and Geoff came up with the clever and original idea of employing a sliding differentially pumping vacuum seal to provide the radial motion. It was the combination of a rather large beams 2-3cm in the radial direction, a fast rotary motion, and a slow radial scan that made possible the excellent uniformity which was a key feature of our machine.

The dose was controlled by making the rate of radial motion proportional to the dose. That is if the beam current dropped, the rate of radial scan was reduced proportionally thus keeping the dose constant. All of the new Eaton and SEN implanters continue to embody the same principle only the electronics and Faraday cages have been improved so that now uniformities are better than 0.30% can be obtained.

There was very little question over what ion source we would choose. Geoff Ryding had already re-designed the Freeman ion source several times, once at Lintott and twice again at Extrion, and he rapidly came up with the design we are now using and it is very much to his credit that the basic design is essentially unchanged to this day. We did briefly and not very seriously discuss other sources probably even a microwave source as a possible alternative to the Freeman design, but we had very little money ($1.5M total funding) and we could not afford any risky developments. The Freeman source was well known to us and we did not think we would be able to create anything better; and it is only recently, primarily because of work being done in Japan, that a more reliable source may be identifiable.

Between the ion source and the target chamber, there is of course the beam line. We decided to choose an energy of 60keV and extract the beam directly from the source without a second stage of acceleration. George Swanson wanted an 80keV beam, but Geoff was determined to be conservative with the first machines. It was not long before George and the customers as usual had their way and, in fact, the third machine we sold was specified for 80keV. The magnetics of the beam line were designed by Hilton Glavish, a consultant who we were very fortunate to find, because his designs have proven outstanding with the additional advantage that he was able to build the magnet for us at his company Anac Ltd., in Auckland, New Zealand.

The first control system was designed to make use of as much micro processor technology as was available in 1978. We would have like to have gone straight to computer control, but in 1978 this would have been impossible with the few resources we had available and the comparatively primitive nature of the available technology. It is hard to remember now that Apple brought the first PC's into the market as early as 1975.

By April 1979, the prototype implanter was on the floor rapidly reaching the stage when we could switch it on. On a Monday that month late in the afternoon, a court official walked into our company and served papers ordering us to appear in front of a judge three days later to give reasons why we should not be enjoined (that is stopped) from doing business. We were being accused by Varian of stealing their trade secrets! This gave us very little time to prepare our defense, but we were very lucky that our Boston lawyer was available the next morning and the head of the Cutler-Hammer Legal Department was also immediately willing to help. It is interesting that instead of being horrified by the events, he remarked when I telephoned him "Good--I was bored. I'll be on a plane tomorrow and join you." If you know anything about American corporate lawyers, this was a truly remarkable and for me welcome attitude. The first court session was touch and go, but when Varian refused to tell the court what secrets we were supposed to have stolen and then was forced by the court to make up a list--everything worked out very well. (We had not stolen any secrets so the list was ficticious.) It ended up with us being able to hire whoever we wanted from Varian and many excellent people were able to join us without danger. This occurred just when we started to need more people and you can imagine how helpful it was to be able to hire people who already were familiar with implanter technology.

In May 1979, we started running beams using Ar and BF_3 in the ion source. We resolved not to use PH_3 and AsH_3 in our plant because of the hazardous nature of these gases and when we needed P^+ and As^+ beams, we used a vaporizer very similar to the one now in use. We made a simple and perhaps rather obvious improvement in the vaporizer's design. At Extrion, we had developed a vaporizer which intrinsically was faulty because the oven itself had a temperature gradient along its length which made the performance unstable no matter how closely the temperature was controlled in one region.

Our new design immediately achieved very stable performance which really impressed our first visiting customers most of whom had struggled with the Extrion design. This is an example of one of the many small, but important technical innovations that we were able to incorporate into our new machine. It would have been difficult to make these changes had we stayed at Extrion because as often seems the case as a company grows our most talented people were generally tied up in management meetings or writing five-year plans and did not have time for innovation! This loss of productivity seems to be unavoidable once a company has reached a certain size, but I hope it can be avoided at SEN for a long time to come.

Nova's first order came from Japan when Toshiba agreed to purchase our prototype machine. The order was received in August 1979 and we were allowed to continue working on the implanter in our factory until December 1979 when it was shipped to Kawasakiworks. When we received this order, we decided it was time to release three more machines to production. The first of which was to be completed in November. The Toshiba machine was by no means ready to ship when we received this order. We could run high beam currents for example we were amazed to be able to run 25mA of As^+ and this impressed Toshiba a lot and probably was the reason for the order. It's worth commenting that although we did not know it, the Faraday cage suppression was later discovered to be inadequate and the beam was probably

only about 18mA. Still, it was quite an exciting performance in 1979. Faraday cage suppression was only one of many deficiencies of the early machines. We were unable to reach our specified boron beam currents even when the extracted beam was 30 - 35mA, a current which often caused the early extraction power supplies to blow up. We eventually decided we could not buy a reliable power supply and in 1981 helped Ken Kaiser start KSI to build power supplies for us. He was given space in our building, a development contract and some purchase orders. KSI power supplies started being incorporated in the Nova machine in 1982. Operation at 80 keV then became much more reliable even though we still had many electronic failures in the control system as a result of sparking. It is dreadful to realize most of the surge protection techniques which we are now applying were known to us. We did not spend the time to do it right the first time and it has taken years to improve the EMI protection of the system. In 1979 and 1980, this was only one of many significant development difficulties. Nobody had ever built such a high performance implanter equipment before so that some failures were to be expected. Unfortunately when I look back, it is clear our ability to fix design problems did not match our innovative capability which resulted (and continues to result) in a real drain of engineering energy.

Until Nova was acquired by Eaton in 1981, we operated independently from the rest of Eaton's semiconductor operations and insisted on having our own sales and service activity in the United States and Europe. On the other hand, in Japan we decided to cooperate fully with Eaton's semiconductor equipment activities there and agreed to join those parts of the group that were represented by Kokusai. Mr. Onue and others at Kokusai worked very hard with us and soon Toshiba, Mitsubishi, NEC, and others became our customers. What we were not told when we joined Kokusai was that the rest of Eaton's products were not selling very well in Japan and

Optimetrix, the Eaton stepper company, was not cooperating with the rest of the group and was represented not by Kokusai, but by C. Itoh. Optimetrix also negotiated a manufacturing agreement with SHI in support of C. Itoh's activities in 1981. This was the first involvement of SHI in Eaton's semiconductor business.

A situation rapidly developed in which Nova was pleased with Kokusai's sales and service, but the other Divisions were very dissatisfied and wanted to make a change. Nova's opinion was that the criticism leveled at Kokusai was very unfair. We did not think that Kokusai should be blamed for being unable to sell products which did not meet the needs of the Japanese customers. In spite of our objections, Eaton broke away and there followed a bad period for Nova in Japan.

I am going into some detail about this period as it should be of particular interest to you both as it involves Japan and because it led eventually to SEN coming into existence. Once we had been acquired by Eaton our ability to act independently was greatly reduced, but we did hope to influence Eaton to set up a 100% owned Eaton subsidiary in Japan if we were forced to leave Kokusai. Eaton even went so far as to hire a few people to start this company, three of whom were Mr. Kawakami, Mr. Mannen and Mr. Takahashi joined SEN when it was formed.

For some reason, the management of the Eaton Semiconductor Group decided not to go ahead with this independent company idea probably because the investment was too high, and instead made an agreement with Marubeni Hytech. Our indecisive actions in Japan at this time cost us our lead over Varian. Before this time, we had effectively shut Varian out of the high current market and it was only by very hard work and cut throat pricing that we were able to

re-establish ourselves as the leader in Japan. Marubeni did no better than Kokusai with the other Eaton products and after a while implanter sales completely dominated Eaton's product mix in Japan.

Even during the boom year of 1984, it was apparent that the market in Japan was changing. The Japanese customers were showing an increasing desire to purchase equipment that was made or at least assembled in Japan. This came about because of a natural preference to buy Japanese, but also because foreign equipment had too many defects and Eaton/Nova equipment was unfortunately no exception. In 1984, the yen was weak relative to the dollar which seemed another reason why we should form an alliance with a Japanese company and start manufacturing in Japan. This would mean another change of our face in Japan, but we hoped an alliance with a top Japanese company would soon overcome any customer dissatisfaction.

-Sumitomo Heavy Industries

Eaton has worked closely with SHI since the end of World War II, and therefore it came as no surprise when Mr. Harada recommended that we form a 50/50 joint venture with Sumitomo Heavy Industries. Luckily for us to bring this about from the Sumitomo side, Dr. Tokunaga had become very interested in the semiconductor equipment industry and in ion implantation in particular. SHI had already became an accelerator manufacturer and was building very large separated sector cyclotrons and small radio active isotope cyclotrons for the medical market. Negotiations on the Eaton side were headed by Mr. Baird our Group President though the detailed negotiations were carried out by George Swanson and Tim Burns (Nova's Controller). After many cordial meetings and tough negotiations SEN was incorporated on December 3, 1982, the Technical Transfer Agreement was signed in 1983 and it was then that the company really came to life.

During our negotiations, we at Eaton/Nova came to respect and like our intended partners and George Swanson became so interested that when we decided we wanted a senior division person working in SEN as a semi-permanent employee, George very readily volunteered and as you know worked with you at SEN until he retired last year. We thought Dr. Tokunaga would become the President of SEN, but he was not available and Mr. Suzuki, a very dedicated and clever person, took this position and ably brought the company into being. However this is not a history of SEN and if you want one you should ask Mr. Yamasaki or Mr. Tamai to write one!

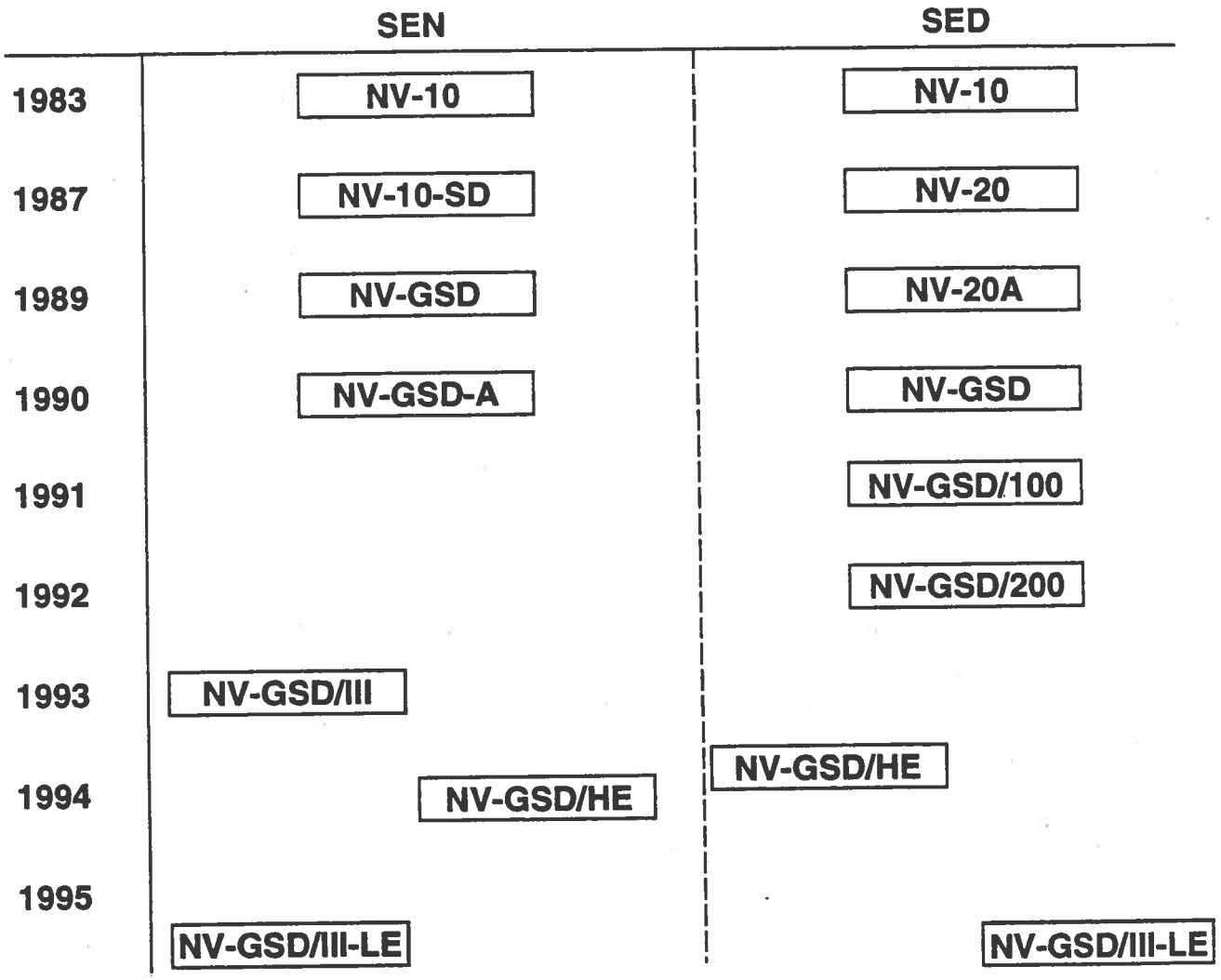
On the date of formation of SEN, the Board was:

M. C. Baird, Group President
G. Swanson, Vice President Marketing
A. Harada, President, Eaton Japan
J. Bowen, President SEO
S. Gohda, President SHI
A. Naitoh
T. Suzuki, President SEN
H. Tokunaga

I think this shows the importance attached to SEN by both Eaton and SHI by appointing such senior people to the Board. There was not even a place for the founder of Nova although I always attended the board meetings!

This brings me up to a time when many of you became involved in Eaton/Nova affairs. I have decided to pause in the story here because it brings you up to the start of SEN. However Geoff Ryding and I have decided to take this outline and see if we cannot make something better out of it in the next few months. Henry Ford is quoted as saying "History is bunk". I think that was a silly thing to say, we can learn from our past and with the extra understanding gained to do a better job in the future. I hope Geoff and I by writing with understanding and historical accuracy can by writing this history contribute to the future growth of our companies.

PRODUCT EVOLUTION



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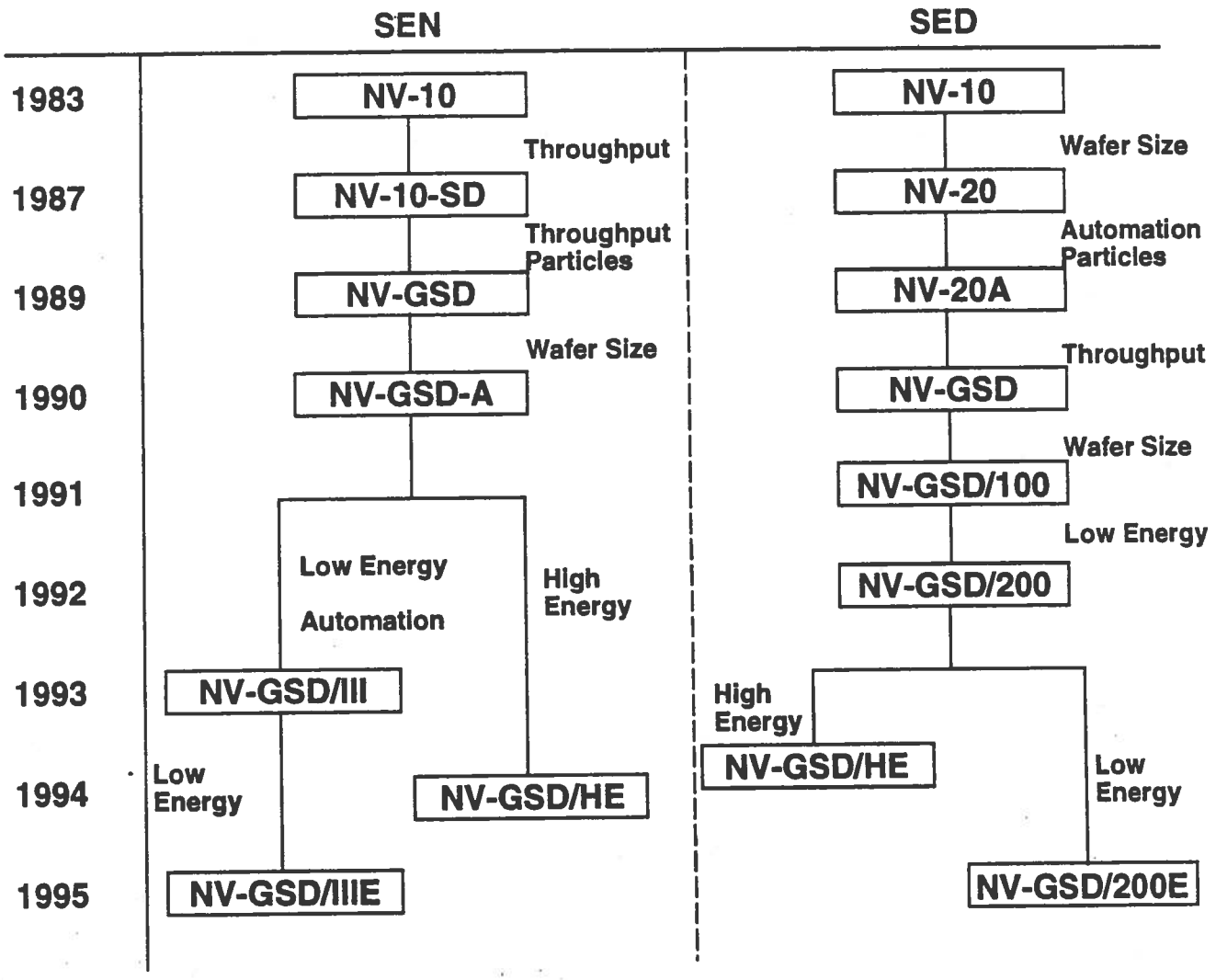
500001 12/16/94

EATON

PRODUCT EVOLUTION (CUSTOMER REQUEST)

needs/ requirements different in each region



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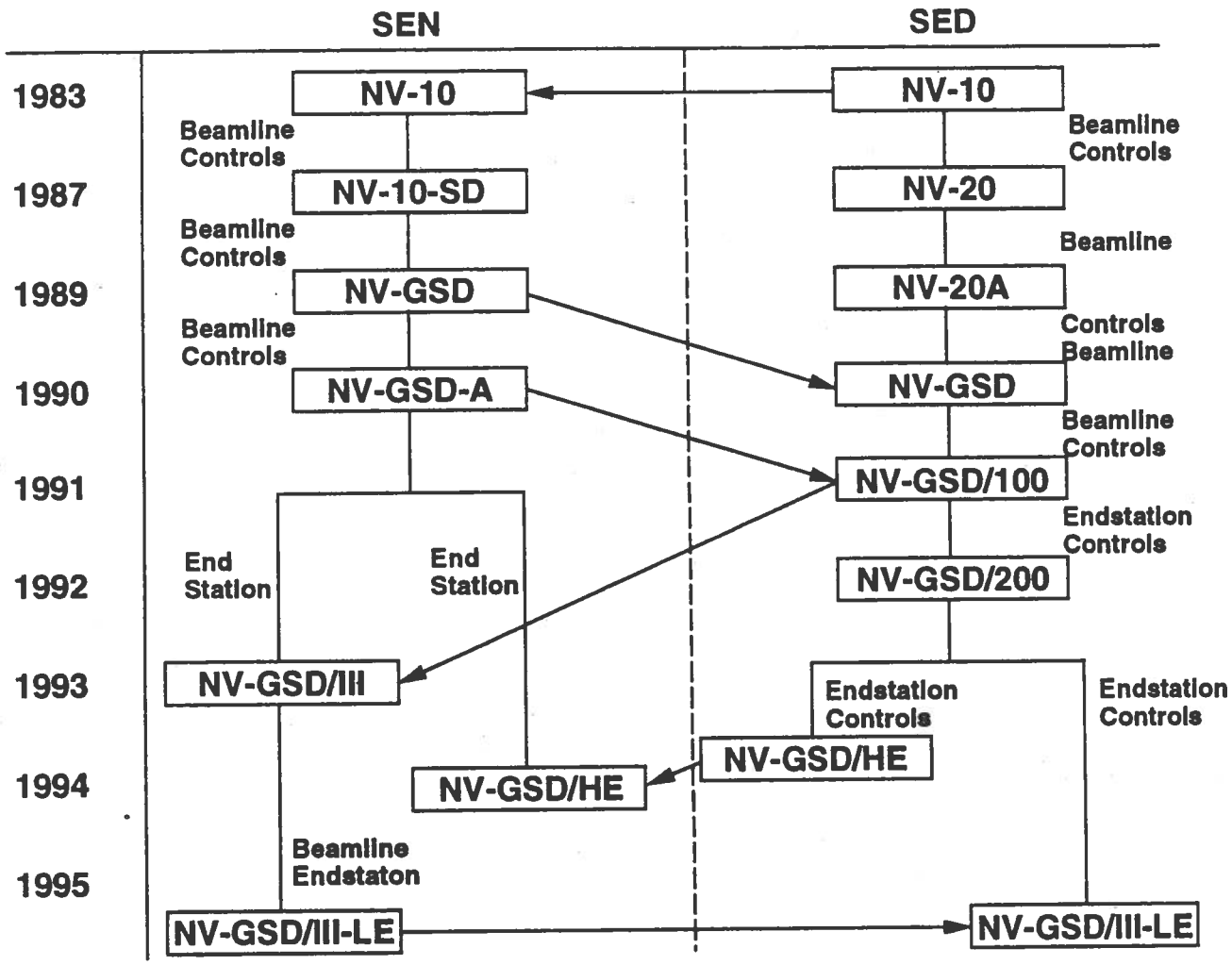
EATON

PRODUCT EVOLUTION (COMMON PARTS)



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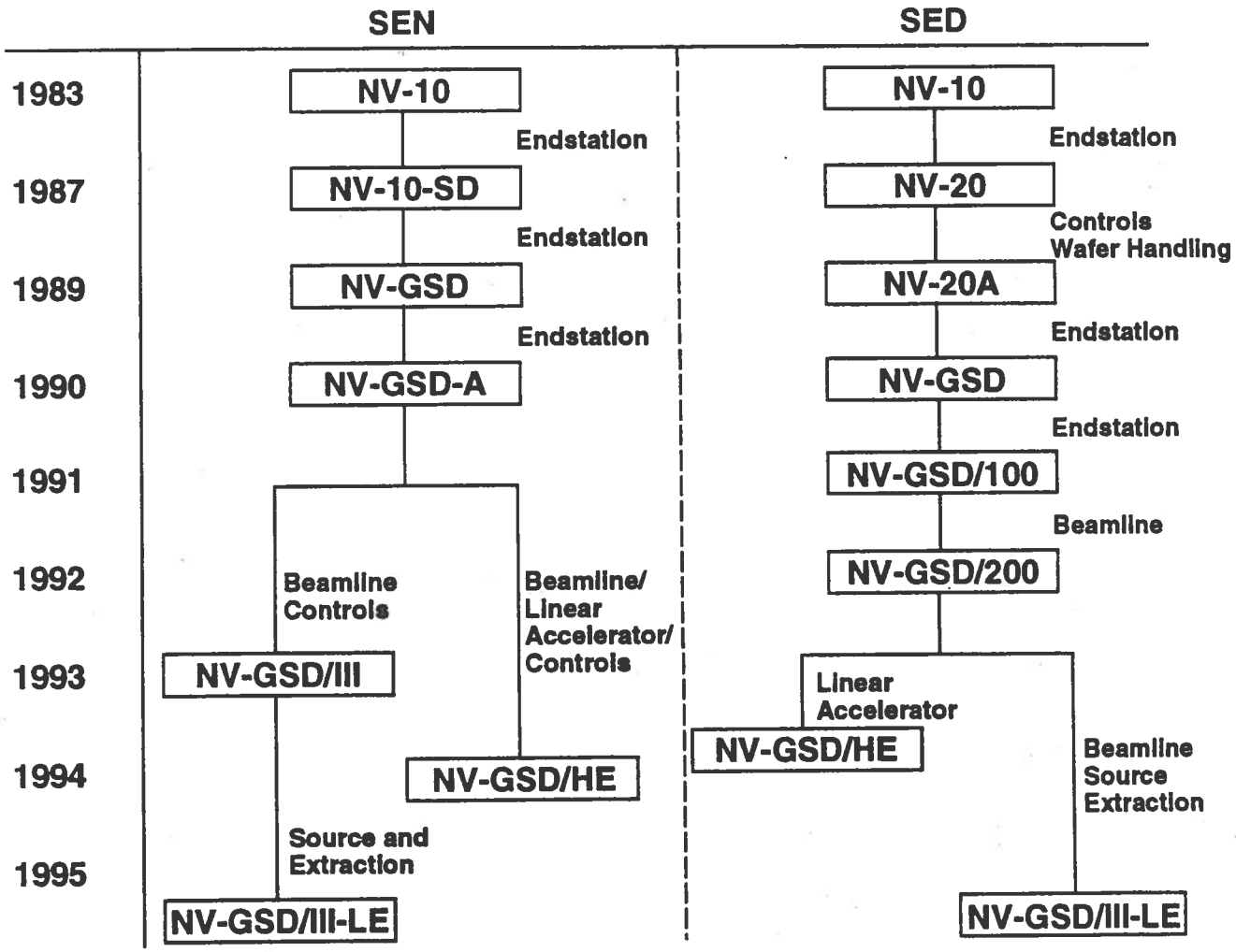
PRODUCT EVOLUTION (CHANGES)



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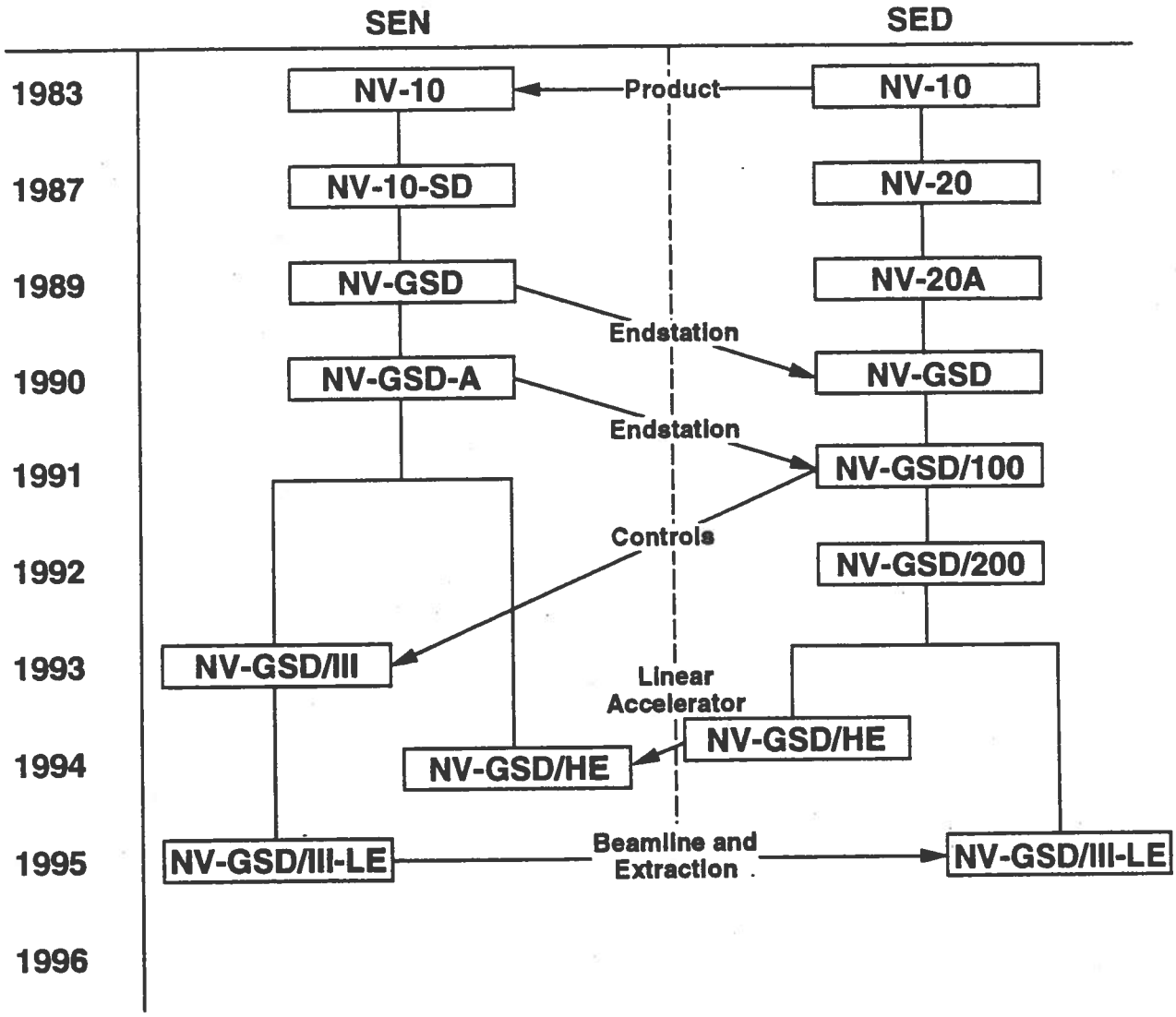
PRODUCT EVOLUTION (TRANSFERS)



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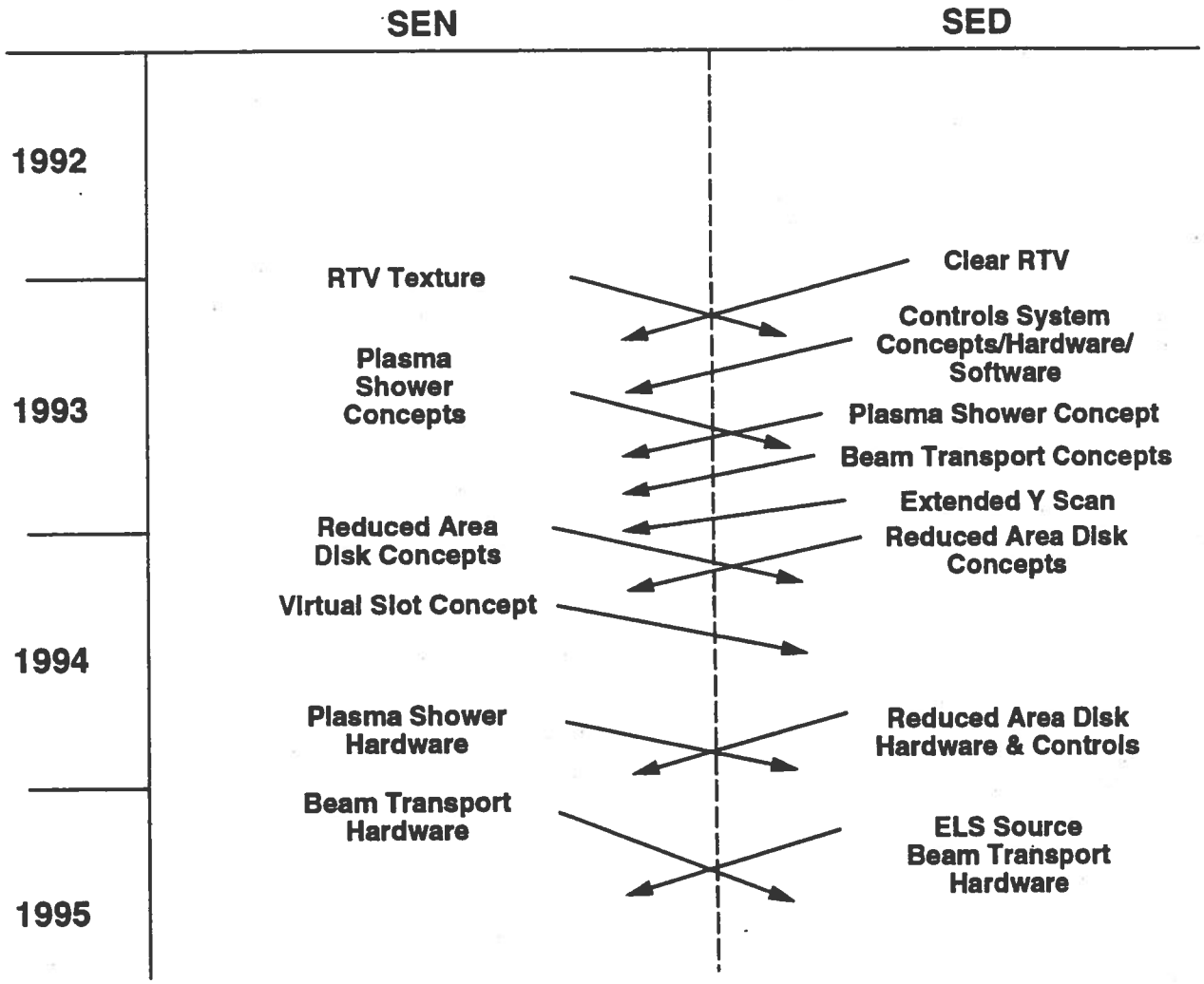
PRODUCT EVOLUTION (TRANSFER DETAILS)



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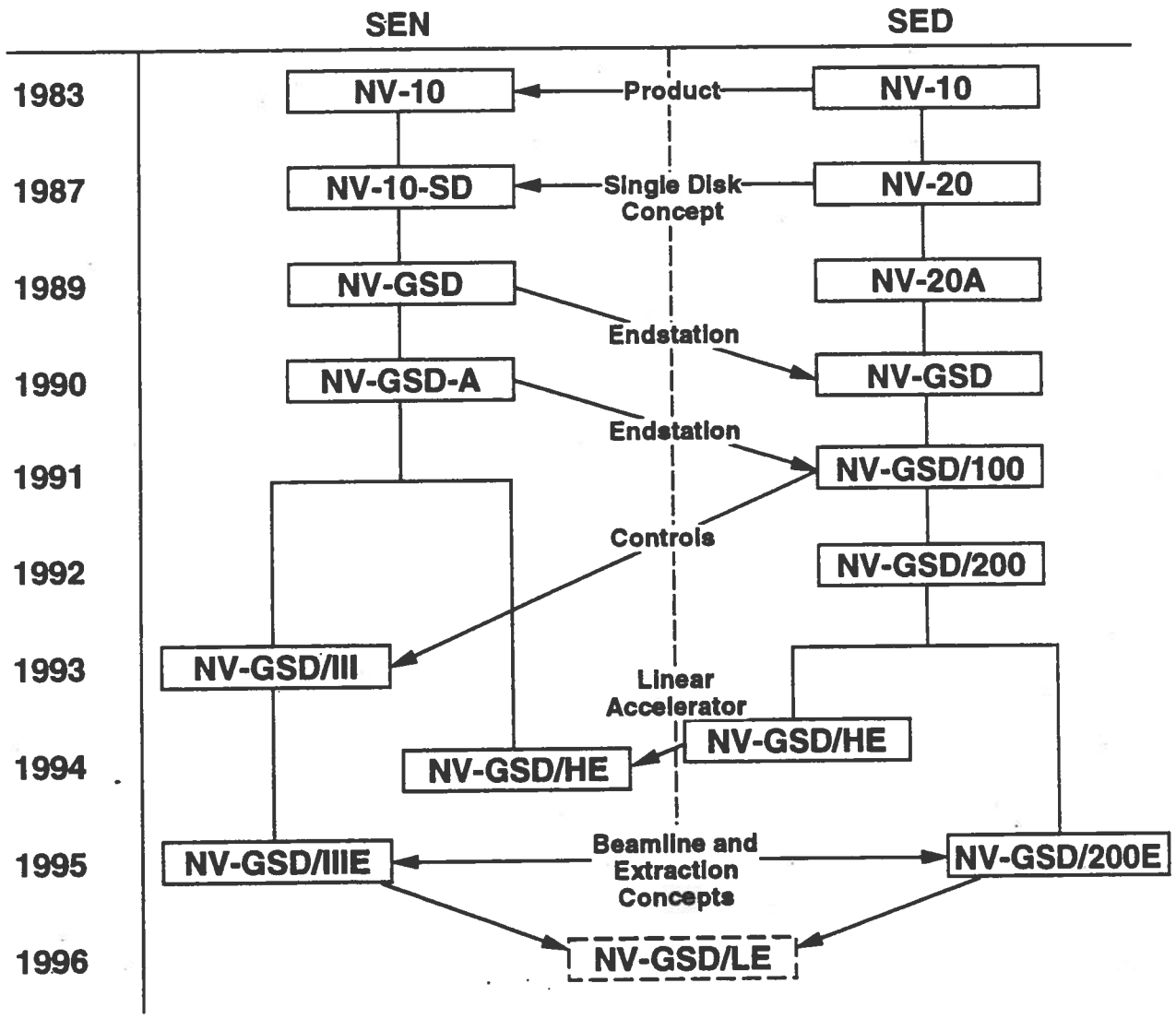
PRODUCT EVOLUTION (TRANSFERS)



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